STUDIES ON THE PERSISTENT POLARIZATION PHENOMENON IN POLAR POLYMERIC SYSTEMS

BY

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TO MY BELOVED PARENTS

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ABSTRACT

Persistent polarization phenomenon can be studied by various techniques. However, no single technique can provide complete information regarding its complex nature. Nevertheless, when the results of different techniques are combined together, an overall view of the phenomenon can be obtained. Here, an attempt has been made to explore and understand the nature of polarization phenomenon by applying several established techniques. The studies are essentially confined to the acrylonitrile polymers.

The virgin films of PAN, SAN and ABS polymers showed a spontaneous current of the order 10^{-11} Amp, when heated linearly. The TSC technique was extensively applied to SAN and ABS, in order to understand their dielectric relaxation mechanism as well as their thermoelectret characteristics. In the case of SAN, a complex TSC spectrum consisting of four peaks was observed; which were attributed to the dielectric relaxations observed by other techniques.The peak-cleaning and partial heating techniques were applied in order to identify the peak positions (68, 107 and 123^{o}C) and the activation energies associated with those processes (0.370, 0.576 and 0.650 eV). The ABS material, though multiphasic, has given rise to a less complex TSC spectrum of three peaks. The influence of the polarizing conditions on the TSC spectrum indicated that there are

critical polarizing conditions to obtain the characteristic spectrum of this material. The total charge released during TSC was found to vary nonlinearly with polarizing field. Interestingly, a sudden and steep rise in total charge was observed for films polarized at temperatures greater than 100^{o}C, as polarization is more facilitated at these temperatures.

The study of dielectric loss and dielectric constant variation with temperature and frequency, in unpolarized and polarized SAN films revealed interesting results. The dielectric loss curves are found to be in close resemblence to the TSC curves. In the case of polarized samples, the dielectric constant had shown abrupt changes at around 60 and 100^{o}C, which approximately correspond to the TSC peak positions. Samples polarized at or above 100^{o}C, showed remarkable changes in dielectric constant values at those temperatures. The dielectric constant and loss showed variation with different polarizing temperatures, as well as field strengths. The TSC and the dielectric results were found to be complementary to each other.

As structure of a polymer is the basic determining factor for its polarization as well as many other properties; a study of the structural changes caused due to polarization, was also made. The DTA results indicated that polarization induces thermal stability in the polymers. The IR analysis revealed that polarization enhances the transmission percentage, differently for different absorption

peaks. The preferential orientation in the polymers due to polarization was investigated with X-ray diffraction techniques. The surface morphology of the polymers was studied with scanning electron microscope. The surfaces of SAN and ABS polymers showed the formation of 'globules' due to linear heating upto 200^{o}C.

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